

IN THE CLAIMS

1. (Currently Amended) A demodulator, comprising:

a multiple differential phase detected signal output unit configured to calculate phase differences between a received signal and previously received signals of 1, 2, ..., N symbols (where N is an integer greater than 2) so as to output 1, 2, ..., N symbol differential phase detected signals; and

a soft decision demodulated data estimating unit configured to estimate a transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and a Viterbi algorithm, and to estimate soft decision demodulated data according to the estimated transmitted differential phase sequence and a survival path metric that transits into each state on the trellis diagram,

wherein the soft decision demodulated data are estimated as the product of hard decision data and reliability information, and the reliability information is calculated by subtracting a likelihood for a first survival path metric having a first state on the trellis diagram from a likelihood for a second survival path metric having a second state defined as a difference between two of the survival path metrics on the trellis diagram.

2. (Currently Amended) The demodulator according to claim 1, wherein, in said soft decision demodulated data estimating unit,

a bit corresponding to the differential phase of a first state having a minimum ~~or a maximum~~ survival path metric on the trellis diagram is hard decision data, and

the first survival path metric is reliability information is defined as a difference between (1) a survival path metric that transits into the first state having a minimum ~~or~~ maximum survival path metric, and (2) the second survival path metric is a survival path

metric that transits into a second state having a minimum ~~or a maximum~~ survival path metric ~~among the states of differential phase obtained by inverting the hard decision data.~~

3. (Currently Amended) A demodulator, comprising:

a multiple differential phase detected signal output unit configured to calculate phase differences between a received signal and previously received signals of 1, 2, ..., N symbols (where N is an integer greater than 2) so as to output 1, 2, ..., N symbol differential phase detected signals;

a power detection unit configured to detect power of the received signal; and

a soft decision demodulated data estimating unit configured to estimate a transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and a Viterbi algorithm, and to estimate soft decision demodulated data according to the estimated transmitted differential phase sequence, a survival path metric that transits into each state on the trellis diagram, and the detected power,

wherein the soft decision demodulated data are estimated as the product of hard decision data and reliability information, and the reliability information is calculated by subtracting a likelihood for a first survival path metric having a first state on the trellis diagram from a likelihood for a second survival path metric having a second state defined as a difference between two of the survival path metrics on the trellis diagram.

4. (Currently Amended) The demodulator according to claim 3, wherein, in said soft decision demodulated data estimating unit,

a bit corresponding to the differential phase of a first state having a minimum ~~or a maximum~~ survival path metric on the trellis diagram is hard decision data, and

~~the first survival path metric is reliability information is defined as the detected power multiplied by a difference between (1) a survival path metric that transits into the first state having a minimum or a maximum survival path metric, and (2) the second survival path metric is a survival path metric that transits into a second state having a minimum or a maximum survival path metric, wherein the reliability information is further multiplied by the detected power among the states of differential phase obtained by inverting the hard decision data.~~

5. (Currently Amended) A demodulator, comprising:

a multiple differential phase detected signal output unit configured to calculate phase differences between a received signal and previously received signals of 1, 2, ..., N symbols (where N is an integer greater than 2) so as to output 1, 2, ..., N symbol differential phase detected signals;

a power detection unit configured to detect power of the received signal;

a  $\rho$ -multiplying unit configured to multiply the detected power by a predetermined number  $\rho$ ; and

a soft decision demodulated data estimating unit configured to estimate transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and a Viterbi algorithm, and to estimate soft decision demodulated data according to the estimated transmitted differential phase sequence, a survival path metric that transits into each state on the trellis diagram, and the  $\rho$ -multiplied value of the detected power,

wherein the soft decision demodulated data are estimated as the product of hard decision data and reliability information, and the reliability information is calculated by

subtracting a likelihood for a first survival path metric having a first state on the trellis diagram from a likelihood for a second survival path metric having a second state defined as a difference between two of the survival path metrics on the trellis diagram.

6. (Currently Amended) The demodulator according to claim 5, wherein, in said soft decision demodulated data estimating unit,

a bit corresponding to the differential phase of a first state having a minimum ~~or a maximum~~ survival path metric on the trellis diagram is hard decision data, and

the first survival path metric is reliability information is defined as the  $\rho$ -multiplied value of the detected power multiplied by a difference between (1) a survival path metric that transits into the first state having a minimum ~~or a maximum~~ survival path metric, and (2) the second survival path metric is a survival path metric that transits into a second state having a minimum ~~or a maximum~~ survival path metric, wherein the reliability information is further multiplied by a  $p$ -multiplied value of the detected power among states of differential phase obtained by inverting the hard decision data.

7. (Currently Amended) A receiver that receives data from a transmitter, said receiver comprising:

a multiple differential phase detected signal output unit configured to calculate phase differences between a received signal and previously received signals of 1, 2, ..., N symbols (where N is an integer greater than 2) so as to output 1, 2, ..., N symbol differential phase detected signals;

a soft decision demodulated data estimating unit configured to estimate a transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of

transmitted signals and a Viterbi algorithm, and to estimate soft decision demodulated data according to the estimated transmitted differential phase sequence and a survival path metric that transits into each state on the trellis diagram,

wherein the soft decision demodulated data are estimated as the product of hard decision data and reliability information, and the reliability information is calculated by subtracting a likelihood for a first survival path metric having a first state on the trellis diagram from a likelihood for a second survival path metric having a second state ~~is defined as a difference between two of the survival path metrics~~ on the trellis diagram; and

a decoding unit configured to decode the original transmitted data based on the soft decision demodulated data.

8. (Currently Amended) A receiver that receives data from a transmitter, said receiver comprising:

a multiple differential phase detected signal output unit configured to calculate phase differences between a received signal and previously received signals of 1, 2, ..., N symbols (where N is an integer greater than 2) so as to output the calculated results as 1, 2, ..., N symbol differential phase detected signals;

a soft decision demodulated data estimating unit configured to estimate a transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and a Viterbi algorithm, and to estimate soft decision demodulated data according to the estimated transmitted differential phase sequence and a survival path metric that transits into each state on the trellis diagram, ~~wherein~~ the soft decision demodulated data being are estimated as the product of hard decision data and reliability information, and the reliability information being calculated by subtracting a likelihood for a first survival path

metric having a first state on the trellis diagram from a likelihood for a second survival path  
metric having a second state ~~is defined as a difference between two of the survival path~~  
~~metrics~~ on the trellis diagram; ~~and~~

a deinterleaving unit configured to deinterleave the soft decision demodulated data according to a predetermined algorithm; and

a decoding unit configured to decode the original transmitted data based on the soft decision demodulated data after the deinterleaving.

9. (Currently Amended) A receiver that receives data from a transmitter, said receiver comprising:

a multiple differential phase detected signal output unit configured to calculate phase differences between a received signal and previously received signals of 1, 2, ..., N (where N is an integer greater than 2) so as to output 1, 2, ..., N symbol differential phase detected signals;

a power detection unit configured to detect power of the received signal;

a soft decision demodulated data estimating unit configured to estimate a transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and a Viterbi algorithm, and to estimate soft decision demodulated data according to the estimated transmitted differential phase sequence, a survival path metric that transits into each state on the trellis diagram, and the detected power, wherein the soft decision demodulated data are estimated as the product of hard decision data and reliability information, and the reliability information is calculated by subtracting a likelihood for a first survival path metric having a first state on the trellis diagram from a likelihood for a second

survival path metric having a second state defined as a difference between two of the survival path metrics on the trellis diagram; and

a decoding unit configured to decode the original transmitted data based on the soft decision demodulated data.

10. (Currently Amended) A receiver that receives data from a transmitter, said receiver comprising:

a multiple differential phase detected signal output unit configured to calculate phase differences between a received signal and previously received signals of 1, 2, ..., N symbols (where N is an integer greater than 2) so as to output 1, 2, ..., N symbol differential phase detected signals;

a power detection unit configured to detect power of the received signal;

a soft decision demodulated data estimating unit configured to estimate a transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and a Viterbi algorithm, and to estimate soft decision demodulated data according to the estimated transmitted differential phase sequence, a survival path metric that transits into each state on the trellis diagram, and the detected power, wherein the soft decision demodulated data are estimated as the product of hard decision data and reliability information, and the reliability information is calculated by subtracting a likelihood for a first survival path metric having a first state on the trellis diagram from a likelihood for a second survival path metric having a second state defined as a difference between two of the survival path metrics on the trellis diagram;

a deinterleaving unit configured to deinterleave the soft decision demodulated data according to a predetermined algorithm; and

a decoding unit configured to decode the original transmitted data based on the soft decision demodulated data after the deinterleaving.

11. (Currently Amended) A receiver that receives data from a transmitter, said receiver comprising:

a multiple differential phase detected signal output unit configured to calculate phase differences between a received signal and previously received signals of 1, 2, ..., N symbols (where N is an integer greater than 2) so as to output 1, 2, ..., N symbol differential phase detected signals;

a power detection unit configured to detect power of the received signal;

a  $\rho$ -multiplying unit configured to multiply the detected power by a predetermined number  $\rho$ ;

a soft decision demodulated data estimating unit configured to estimate a transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and a Viterbi algorithm, and to estimate soft decision demodulated data according to the estimated transmitted differential phase sequence, a survival path metric that transits into each state on the trellis diagram, and the  $\rho$ -multiplied value of the detected power, wherein the soft decision demodulated data are estimated as the product of hard decision data and reliability information, and the reliability information is calculated by subtracting a likelihood for a first survival path metric having a first state on the trellis diagram from a likelihood for a second survival path metric having a second state defined as a difference between two of the survival path metrics on the trellis diagram; and

a decoding unit configured to decode the original transmitted data based on the soft decision demodulated data.



12. (Currently Amended) A receiver that receives data from a transmitter, said receiver comprising:

a multiple differential phase detected signal output unit configured to calculate phase differences between a received signal and previously received signals of 1, 2, ..., N symbols (where N is an integer greater than 2) so as to output 1, 2, ..., N symbol differential phase detected signals;

a power detection unit configured to detect a power of the received signal;

a  $\rho$ -multiplying unit configured to multiply the detected power by a predetermined number  $\rho$ ;

a soft decision demodulated data estimating unit configured to estimate a transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and a Viterbi algorithm, and to estimate soft decision demodulated data according to the estimated transmitted differential phase sequence, a survival path metric that transits into each state on the trellis diagram, and the  $\rho$ -multiplied value of the detected power, wherein the soft decision demodulated data are estimated as the product of hard decision data and reliability information, and the reliability information is calculated by subtracting a likelihood for a first survival path metric having a first state on the trellis diagram from a likelihood for a second survival path metric having a second state defined as a difference between two of the survival path metrics on the trellis diagram;

a deinterleaving unit configured to deinterleave the soft decision demodulated data according to a predetermined algorithm; and

a decoding unit configured to decode the original transmitted data based on the soft decision demodulated data after the deinterleaving.

13. (Currently Amended) A communication system comprising a transmitter for transmitting a data and a receiver for receiving the data, wherein

said transmitter comprises:

a convolutional coding unit configured to convolutionally encode the transmitted data;

a converting unit configured to convert the convolutionally encoded data into a transmission differential phase;

a differential coding unit configured to differentially encode the transmission differential phase and to map the differentially encoded data to the signal phases; and

a transmission signal generation/output unit configured to generate/output a differential phase modulated signal based on the transmission signal phase,

said receiver comprises:

a multiple differential phase detection signal output unit configured to calculate phase differences between a received signal and previously received signals of 1, 2, ..., N symbols (where N is an integer greater than 2) so as to output 1, 2, ..., N symbol differential phase detected signals;

a soft decision demodulated data estimating unit configured to estimate a transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and a Viterbi algorithm, and to estimate soft decision demodulated data according to the estimated transmitted differential phase sequence and a survival path metric that transits into each state on the trellis diagram, wherein the soft decision demodulated data are estimated as the product of hard decision data and reliability information, and the reliability information is calculated by subtracting a likelihood for a first survival path metric

having a first state on the trellis diagram from a likelihood for a second survival path metric  
having a second state defined as a difference between two of the survival path metrics on the  
trellis diagram; and

a decoding unit configured to decode the original transmitted data based on the soft decision demodulated data.

14. (Currently Amended) A communication system comprising a transmitter for transmitting a data and a receiver for receiving the data, wherein

said transmitter comprises:

a convolutional coding unit configured to convolutionally encode the transmitted data;

an interleaving unit configured to interleave an order of the convolutionally-encoded data according to a predetermined algorithm;

a converting unit configured to convert the interleaved data into a transmission differential phase;

a differential coding unit configured to differentially encode the transmission differential phase and to map the differentially encoded data to the signal phases; and

a transmission signal generation/output unit configured to generate/output a differential phase modulated signal based on the transmission signal phase,

said receiver comprises:

a multiple differential phase detected signal output unit configured to calculate phase differences between a received signal and previously received signals of 1, 2, ..., N symbols (where N is an integer greater than 2) so as to output 1, 2, ..., N symbol differential phase detected signals;

a soft decision demodulated data estimating unit configured to estimate a transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and a Viterbi algorithm, and to estimate soft decision demodulated data according to the estimated transmitted differential phase sequence and a survival path metric that transits into each state on the trellis diagram, wherein the soft decision demodulated data are estimated as the product of hard decision data and reliability information, and the reliability information is calculated by subtracting a likelihood for a first survival path metric having a first state on the trellis diagram from a likelihood for a second survival path metric having a second state ~~defined as a difference between two of the survival path metrics~~ on the trellis diagram;

a deinterleaving unit configured to deinterleave the soft decision demodulated data according to the predetermined algorithm; and

a decoding unit configured to decode the original transmitted data based on the soft decision demodulated data after the deinterleaving.

15. (Currently Amended) A communication system comprising a transmitter for transmitting a data and a receiver for receiving the data, wherein

said transmitter comprises:

a convolutional coding unit configured to convolutionally encode the transmitted data;

a converting unit configured to convert the convolutionally encoded data into a transmission differential phase;

a differential coding unit configured to differentially encode the transmission differential phase and to map the differentially encoded data to the signal phases; and

a transmission signal generation/output unit configured to generate/output a differential phase modulated signal based on the transmission signal phase,

said receiver comprises:

a multiple differential phase detected signal output unit configured to calculate phase differences between a received signal and previously received signals of 1, 2, ..., N symbols (where N is an integer greater than 2) so as to output 1, 2, ..., N symbol differential phase detected signals;

a power detection unit configured to detect power of the received signal;

a soft decision demodulated data estimating unit configured to estimate transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and a Viterbi algorithm, and to estimate soft decision demodulated data according to the estimated transmitted differential phase sequence, a survival path metric that transits into each state on the trellis diagram, and the detected power, wherein the soft decision demodulated data are estimated as the product of hard decision data and reliability information, and the reliability information is calculated by subtracting a likelihood for a first survival path metric having a first state on the trellis diagram from a likelihood for a second survival path metric having a second state ~~defined as a difference between two of the survival path metrics on the trellis diagram~~; and

a decoding unit configured to decode the original transmitted data based on the soft decision demodulated data.

16. (Currently Amended) A communication system comprising a transmitter for transmitting a data and a receiver for receiving the data, wherein

said transmitter comprises:

a convolutional coding unit configured to convolutionally encode the transmitted data;

an interleaving unit configured to interleave an order of the convolutionally-encoded data according to a predetermined algorithm;

a converting unit configured to convert the interleaved data into a transmission differential phase;

a differential coding unit configured to differentially encode the transmission differential phase and to map the differentially encoded data to the signal phases; and

a transmission signal generation/output unit configured to generate/output a differential phase modulated signal based on the transmission signal phase,

said receiver comprises:

a multiple differential phase detected signal output unit configured to calculate phase differences between a received signal and previously received signals of 1, 2, ..., N symbols (where N is an integer greater than 2) so as to output 1, 2, ..., N symbol differential phase detected signals;

a power detection unit configured to detect power of the received signal;

a soft decision demodulated data estimating unit configured to estimate a transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and a Viterbi algorithm, and configured to estimate soft decision demodulated data according to the estimated transmitted differential phase sequence, a survival path metric that transits into each state on the trellis diagram, and the detected power, wherein the soft decision demodulated data are estimated as the product of hard decision data and reliability information, and the reliability information is calculated by subtracting a likelihood for a first survival path metric having a first state on the trellis

diagram from a likelihood for a second survival path metric having a second state defined as  
~~a difference between two of the survival path metrics~~ on the trellis diagram;

a deinterleaving unit configured to deinterleave the soft decision demodulated data according to the predetermined algorithm; and

a decoding unit configured to decode the original transmitted data based on the soft decision demodulated data after the deinterleaving.

17. (Currently Amended) A communication system comprising a transmitter for transmitting a data and a receiver for receiving the data, wherein

said transmitter comprises:

a convolutional coding unit configured to convolutionally encode the transmitted data;

a converting unit configured to convert the convolutionally encoded data into a transmission differential phase;

a differential coding unit configured to differentially encode the transmission differential phase and to map the differentially encoded data to the signal phases; and

a transmission signal generation/output unit configured to generate/output a differential phase modulated signal based on the transmission signal phase,

said receiver comprises:

a multiple differential phase detected signal output unit configured to calculate phase differences between a received signal and previously received signals of 1, 2, ..., N symbols (where N is an integer greater than 2) so as to output 1, 2, ..., N symbol differential phase detected signals;

a power detection unit configured to detect power of the received signal;

a  $\rho$ -multiplying unit configured to multiply the detected power by a predetermined number  $\rho$ ;

a soft decision demodulated data estimating unit configured to estimate a transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and a Viterbi algorithm, and to estimate soft decision demodulated data according to the estimated transmitted differential phase sequence, a survival path metric that transits into each state on the trellis diagram, and the  $\rho$ -multiplied value of the detected power, wherein the soft decision demodulated data are estimated as the product of hard decision data and reliability information, and the reliability information is calculated by subtracting a likelihood for a first survival path metric having a first state on the trellis diagram from a likelihood for a second survival path metric having a second state ~~defined as a difference between two of the survival path metrics~~ on the trellis diagram; and

a decoding unit configured to decode the original transmitted data based on the soft decision demodulated data.

18. (Currently Amended) A communication system comprising a transmitter for transmitting a data and a receiver for receiving the data, wherein

said transmitter comprises:

a convolutional coding unit configured to convolutionally encode the transmitted data;

an interleaving unit configured to interleave an order of the convolutionally-encoded data according to a predetermined algorithm;

a converting unit configured to convert the interleaved data into a transmission differential phase;



a differential coding unit configured to differentially encode the transmission differential phase and to map the differentially encoded data to the signal phases; and

a transmission signal generation/ output unit configured to generate/output a differential phase modulated signal based on the transmission signal phase,

said receiver comprises:

a multiple differential phase detected signal output unit configured to calculate phase differences between a received signal and previously received signals of 1, 2, ..., N symbols (where N is an integer greater than 2) so as to output 1, 2, ..., N symbol differential phase detected signals;

a power detection unit configured to detect power of the received signal;

a  $\rho$ -multiplying unit configured to multiply the detected power by a predetermined number  $\rho$ ;

a soft decision demodulated data estimating unit configured to estimate transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and a Viterbi algorithm, and to estimate soft decision demodulated data according to the estimated transmitted differential phase sequence, a survival path metric that transits into each state on the trellis diagram, and the  $\rho$ -multiplied value of the detected power, wherein the soft decision demodulated data are estimated as the product of hard decision data and reliability information, and the reliability information is calculated by subtracting a likelihood for a first survival path metric having a first state on the trellis diagram from a likelihood for a second survival path metric having a second state defined as a difference between two of the survival path metrics on the trellis diagram;

a deinterleaving unit configured to deinterleave the soft decision demodulated data according to the predetermined algorithm; and

a decoding unit configured to decode the original transmitted data based on the soft decision demodulated data after the deinterleaving.